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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Lewis et al.                      Art Unit : 1743  
Serial No.: 09/409,644                      Examiner : Arlen Soderquist  
Filed : October 1, 1999  
Title : CONDUCTIVE ORGANIC SENSORS, ARRAYS AND METHODS OF  
USE

**Mail Stop Appeal Brief - Patents**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**BRIEF ON APPEAL**

Sir:

Applicant herewith files this brief on appeal, thereby perfecting the Notice of Appeal originally mailed on August 20, 2004. The categories and subjects required by rule 192 follow:

**(1) Real Parties in Interest**

The application is assigned of record to California Institute of Technology, who is hence a real party in interest. Carol Lewis, an inventor, is also a real party in interest.

**(2) Related Appeals and Interferences**

There are no known related appeals or interferences.

**CERTIFICATE OF MAILING BY FIRST CLASS MAIL**

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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**(3) Status of Claims**

Claims 1-49, 73-84, 91-97, 111, and 124-125 are canceled. Claims 50-72, 85-90, 98-110, 112-123 and 126-159 are pending. Of those claims, claims 50-72 and 85-90 are withdrawn from consideration. Claims 98-110, 112-123 and 126-159 stand rejected.

**(4) Status of Amendments**

A response after final was filed on July 12, 2004. No amendments were introduced in the response. Applicants' remarks were entered in full in paper number 36.

**(5) Summary of Claimed Subject Matter**

Claims 98, 104-106, 108, 126-128, 148 and 152 are independent claims.

Claim 98 is directed to a sensor device. The sensor device comprises a chemically sensitive resistor or sensing area between at least two conductive leads (page 25, lines 1-3; FIG. 1A and 1A-1). The sensing area comprises two compositionally different conductive materials (page 7, line 22 to page 8, line 1; page 54, lines 10-17). One of the materials is a conductive organic material (page 7, line 23; page 54, lines 10-17) and the other is selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof (page 8, lines 6-11; Table 2, page 28) and has an electrical conductivity that decreases as the temperature increases (page 34, lines 9-14). The at least two conductive leads are

connected to an apparatus capable of measuring changes in the conductivity between the conductive leads (page 9, line 21 to page 10, line 1; page 59, line 22 to page 60, line 10).

Claim 104 is directed to a sensor device. The sensor device comprises a sensing area between at least two conductive leads (page 25, lines 1-3; FIG. 1A and 1A-1). The sensing area comprises alternating interpenetrating regions (page 25, line 12; page 53, line 13) of two compositionally different conductive materials (page 7, line 22 to page 8, line 1; page 54, lines 10-17). One of the materials is a conductive organic material and the other, compositionally different conductive material, is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof (page 8, lines 6-11; Table 2, page 28) and has an electrical conductivity that decreases as the temperature increases (page 34, lines 9-14). The at least two conductive leads are connected to an apparatus capable of measuring changes in the conductivity between the conductive leads (page 9, line 21 to page 10, line 1; page 59, line 22 to page 60, line 10). The sensing area is in direct contact with a vapor comprising an analyte to be detected.

Claim 105 is directed to a sensor device. The sensor device comprises a sensing area between at least two conductive leads (page 25, lines 1-3; FIG. 1A and 1A-1). The sensing area comprises dispersed interpenetrating regions of two compositionally different conductive materials (page 7, line 22 to page 8, line 1; page 54, lines 10-17). One of the conductive materials is a conductive organic material and the other,

compositionally different conductive material, is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof (page 8, lines 6-11; Table 2, page 28) and has an electrical conductivity that decreases as the temperature increases (page 34, lines 9-14). The at least two conductive leads are connected to an apparatus capable of measuring changes in the conductivity between the conductive leads (page 9, line 21 to page 10, line 1; page 59, line 22 to page 60, line 10). The sensing area is in direct contact with a vapor comprising an analyte to be detected.

Claim 106 is directed to a sensor device. The sensor device comprises a sensing area between at least two conductive leads (page 25, lines 1-3; FIG. 1A and 1A-1). The sensing area comprises alternating interpenetrating regions of a polyaniline or an emeraldine salt of polyaniline (page 27, lines 1-17) and a compositionally different conductive material (page 7, line 22 to page 8, line 1; page 54, lines 10-17). The at least two conductive leads are connected to an apparatus capable of measuring changes in the conductivity between the conductive leads (page 9, line 21 to page 10, line 1; page 59, line 22 to page 60, line 10).

Claim 108 is directed to a sensor array comprising a plurality of sensors. At least one of the sensors of the array comprises a sensing area between at least two conductive leads (page 25, lines 1-3; FIG. 1A and 1A-1). The sensing area comprises alternating interpenetrating regions (page 25, line 12; page 53, line 13) of two compositionally different

conductive materials (page 7, line 22 to page 8, line 1; page 54, lines 10-17). One of the materials is a conductive organic material and the other, compositionally different conductive material, is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof (page 8, lines 6-11; Table 2, page 28) and has an electrical conductivity that decreases as the temperature increases (page 34, lines 9-14). The sensing area is in direct contact with a vapor comprising an analyte to be detected.

Claim 126 is directed to a sensor array comprising a plurality of sensors. At least one of the sensors of the array comprises a sensing area between at least two conductive leads (page 25, lines 1-3; FIG. 1A and 1A-1). The sensing area comprises alternating interpenetrating regions (page 25, line 12; page 53, line 13) of two compositionally different conductive materials (page 7, line 22 to page 8, line 1; page 54, lines 10-17). One of the materials is a conductive organic material and the other, compositionally different conductive material, is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof (page 8, lines 6-11; Table 2, page 28) and has an electrical conductivity that decreases as the temperature increases (page 34, lines 9-14). The at least two conductive leads are connected to an apparatus capable of measuring changes in the conductivity between the

conductive leads (page 9, line 21 to page 10, line 1; page 59, line 22 to page 60, line 10). The sensing area is in direct contact with a vapor comprising an analyte to be detected.

Claim 127 is directed to a sensor array comprising a plurality of sensors. At least one of the sensors of the array comprises alternating interpenetrating regions (page 25, line 12; page 53, line 13) of two compositionally different conductive materials (page 7, line 22 to page 8, line 1; page 54, lines 10-17). The sensing area is in direct contact with a vapor comprising an analyte to be detected. The subject matter of the claim further includes "means" electrically coupled to the plurality of sensors for detecting a change in the plurality of sensors when contacted with an analyte. In this particular claim, the means may be interpreted as means plus function. The corresponding structures that may be associated with the "means" include conductive leads and an electrical measuring device such as that described at page 9, line 21 to page 10, line 1; page 25, lines 1-3; FIG. 1A and 1A-1; page 59, line 22 to page 60, line 10.

Claim 128 is directed to a sensor array comprising a plurality of sensors. At least one of the sensors of the array comprises a sensing area between at least two conductive leads (page 25, lines 1-3; FIG. 1A and 1A-1). The sensing area comprises alternating interpenetrating regions (page 25, line 12; page 53, line 13) of two compositionally different conductive materials (page 7, line 22 to page 8, line 1; page 54, lines 10-17). One of the materials is a conductive organic material and the other, compositionally different conductive material, is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor, and a

mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof (page 8, lines 6-11; Table 2, page 28) and has an electrical conductivity that decreases as the temperature increases (page 34, lines 9-14). The at least two conductive leads are connected to an apparatus capable of measuring changes in the conductivity between the conductive leads (page 9, line 21 to page 10, line 1; page 59, line 22 to page 60, line 10). The sensing area is in direct contact with a vapor comprising an analyte to be detected. A computer with a resident algorithm processes the changes measured by the measuring apparatus.

Claim 148 is directed to a system for identifying a microorganism (page 22, lines 3-5; page 23, lines 13-16; Table 1, page 24). The system comprises a sensor array comprising a plurality of sensors. At least one of the sensors of the array comprises a sensing area between at least two conductive leads (page 25, lines 1-3; FIG. 1A and 1A-1). The sensing area comprises alternating regions (page 25, line 12; page 53, line 13) of two compositionally different conductive materials (page 7, line 22 to page 8, line 1; page 54, lines 10-17). One of the materials is a conductive organic material and the other, compositionally different conductive material, is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof (page 8, lines 6-11; Table 2, page 28) and has an electrical conductivity that decreases as the temperature increases (page 34, lines 9-14). The at least two conductive leads are

connected to an apparatus capable of measuring changes in the conductivity between the conductive leads (page 9, line 21 to page 10, line 1; page 59, line 22 to page 60, line 10). The sensing area is in direct contact with a vapor comprising an analyte to be detected. A computer with a resident algorithm processes the changes measured by the measuring apparatus.

Claim 152 is directed to a system for detecting an analyte. The system comprises a substrate having a plurality of sensors. At least one sensor comprises at least two conductive leads and a sensing area between the at least two conductive leads (page 25, lines 1-3; FIG. 1A and 1A-1). The sensing area comprising alternating interpenetrating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material (page 7, line 22 to page 8, line 1; page 54, lines 10-17) disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material such that the at least one sensor provides a response that varies according to the presence of an analyte in contact with it. The sensing area is in direct contact with a vapor comprising an analyte to be detected. Furthermore, the compositionally different conductive material is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, or a superconductor, or a combination thereof (page 8, lines 6-11; Table 2, page 28) and wherein the inorganic conductor has an electrical conductivity that decreases as the temperature



increases (page 34, lines 9-14). A detector is operatively associated with the plurality of sensors, for measuring the response of the plurality of sensors when contacted with the sample. The system further comprises a sample delivery unit for delivering the sample to be tested to the plurality of sensors. An information storage and processing device is present and configured to store an ideal response for a predetermined analyte and to compare the response of the plurality of sensors with the stored ideal response, to detect the presence of the analyte in the sample.

#### **(6) Grounds of Rejection**

The Examiner maintains that claims 98-110, 112-123 and 126-159 are allegedly unpatentable under 35 U.S.C. §103(a) over Gibson (WO 96/07901) in view of Barisci (Trends in Polymer Science, 1996) and Casella (Analytica Chimica Acta, 335:217-225, 1996), Thackeray (J. Phys. Chem., 90(25):6674-6679, 1995), Yamato (Synth. Met. 87:231-236, 1997), Naarmann (DE 3,728,452), Li (Materials Research Society Symposium Proceedings, 1995), Sakaguchi (JP 4-2958), Stetter (U.S. 5,512,882) or Wampler (Chem. Mater. 7(3):585-592, 1995) and Breheret (Colloq. Inst. Natl. Rech. Agron. 75:103-107, 1995), Mifsud I (5,801,297), Mifsud II (WO 95/08113), Moy (Bioflavour 95(75):55-58, 1995) or Persaud (WO 86/01599).

#### **(7) Argument**

Applicants respectfully submit that the rejection has not set forth a *prima facie* case of obviousness. First, the rejection has not set forth any suggestion or motivation, either in the references themselves or in the knowledge generally

available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. In fact, the knowledge generally available in the art at the time of Applicants' earliest priority date teaches away from combining the references. Furthermore, if the references were combined, the alleged teachings of the references would lead to a result that does not function in a manner of Applicants' invention. Second, even if the references were combined, the teaching of the combination fail to teach or suggest each and every element of Applicants' claimed invention. Third, the Examiner has not provided a reasonable expectation of success.

### **I. The Technology**

The sensor systems for the purposes of this Appeal can be divided into two general categories: (1) Conductimetric sensors and (2) Amperometric sensors (sometimes referred to as electrochemical sensors).

#### **A. Conductimetric Sensors**

A general structural schematic and system of a conductimetric sensor and system are provided in FIG. 1, attached hereto. FIG. 1 shows two conductive leads (10) on opposite ends and separated by a sensing area (20). The sensing area can be disposed upon a non-conductive substrate backing or other material (30). The sensing area comprises a conductive organic material (40) and a conductive material compositionally different than the conductive organic material (50). An electrical measuring device (60) is coupled to the conductive leads (10) and measuring the resistance between the leads (*i.e.*, the electrical conductivity/resistance of the sensing area).

During operation the sensing area (20) absorbs, adsorbs or imbibes an analyte (70). The analyte causes the conductive materials to change in conductivity thereby causing a measurable change in resistance as measured by the electrical measuring device (60). This change in conductivity/resistance is used to determine if a particular analyte or class of analytes is present in a sample.

#### **B. Amperometric-Electrochemical Sensors**

A general structural schematic and system of an amperometric-electrochemical sensor is provided in FIG. 2, attached hereto. With reference to FIG. 2 there is shown three electrodes (10A-C) each connected to an electrical measuring device (20) by a single conductive lead (30). An amperometric-electrochemical sensor system requires additional electrodes immersed in a liquid electrolyte. Each electrode (10) is attached to a circuit using a single conductive lead (30). The electrons (40) involved in the electrochemical reaction flow from the working electrode (10a) through the external circuit (50), producing the output signal of the sensor. An analyte is contacted with, for example, an aqueous buffer (60) that is in contact with a sensor. The analyte does not initially come into direct contact with the sensor. The sensor of the electrochemical system undergoes an oxidation or reduction thereby changing electron flow through the system between a cathode electrode and an anode electrode.

## II. The Cited References

The references can be divided into two general categories similar to the categories of the technology (i.e., conductimetric and amperometric-electrochemical sensors).

### **A. The Primary Reference, Gibson**

The primary reference, Gibson, is directed to the general field of conductimetric sensors. Gibson, however, does not teach each and every element of Applicants' claimed invention. The Examiner agrees that Gibson, as the primary reference, does not anticipate the claims. However, the Examiner alleges that the "monomers" disclosed in Gibson are considered compositionally different materials for the purposes of Applicants' claimed invention. Applicants respectfully disagree.

#### 1. Gibson Does Not Teach Two Different Conductive Materials

The Office Action alleges that page 12 of Gibson teaches a material having two different monomers used to form a copolymer, which the Examiner is treating as within the scope of two different conducting materials. Applicants respectfully disagree that the polymers of Gibson are within the scope of two compositionally different conductive materials.

Applicants respectfully submit that two monomers when reacted together do not form two "compositionally different" materials. The two monomers are reacted together to become a single polymeric material that cannot be separated into two monomeric materials for purposes of defining the properties in

the polymeric material. Furthermore, a polymer has physical-chemical properties specific for the polymer, not the monomers. This is a fundamental principle of chemistry. When two monomers are reacted to become a polymer, the conductive properties of the polymer are not the conductivity of each monomer but are the physical-chemical (i.e., conductive) properties of *the polymer, not the monomers*. In contrast, Applicants' claims recite that the conductive materials are compositionally different. For example, gold has conductive properties that are independent of the conductive properties of a conducting polymer (e.g., polythiophene).

2. Gibson Does Not Teach Or Suggest Materials Comprising Non-Organic Polymers

Applicant's claims clearly recite that the sensing area comprises "...alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads. . ." (see, e.g., claim 98). The Office Action mailed May 7, 2003 (Paper No. 29) states at page 3, lines 13-16, "Gibson does not teach . . . two materials . . . mixed together to form as a single sensing material having the compositionally different conductive material within the conductive organic material or as a sensing array having sensors that are not organic polymer based." This quotation from the Office Action and by the Examiner's admission clearly indicates that Gibson does not teach or suggest Applicants' claimed invention.

Applicants submit that Gibson does not teach or suggest a compositionally different conductive material:

. . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

The Examiner agrees at page 3 of the Final Office Action mailed April 20, 2004 (Paper No. 35) that Gibson does not teach or suggest such "[non]-organic polymer based" sensors.

Furthermore, Applicants submit that Gibson fails to teach or suggest a compositionally different material:

. . .wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases. . .

Thus, Gibson alone does not teach or suggest Applicants' claimed invention as the Gibson reference does not teach or suggest each and every element of Applicants' claimed invention. To overcome the deficiencies of Gibson the Examiner attempts to combine additional references directed to amperometric-electrochemical sensors.

**B. Amperometric-Electrochemical Sensors Do Not Meet The Elements Of Applicants' Claimed Invention And There Is No Motivation To Combine Casella, Thackeray et al., Yamato et al., Naarman, and Li**

As described in Section I, above, amperometric-electrochemical sensors are structurally and functionally different than conductimetric sensors and sensor systems. The following cited references teach "amperometric-electrochemical

sensors" such as those in FIG. 2, which are fundamentally different in operation and composition than the claimed sensors.

- Casella teaches a sensor layered with polyaniline. The Casella sensor measurements are done using an electrochemical system such as that presented in FIG. 2. For example, Casella teaches at page 218, §2.2 "Apparatus", that "[c]yclic voltammetry (CV) was done in a three-electrode cell using a Cu-PANI working electrode, a saturated calomel reference electrode (SCE) . . . and a platinum foil counter electrode." As such the Casella sensor has only a single conductive lead attached to each "electrode" and measures redox reactions upon the sensor material.
- Thackeray et al. is electrochemical in nature, requiring an aqueous media containing ions to maintain a potential on the electrode. The electrochemical reaction involves a transfer of faradic charge and associated ions between the electrode of Thackeray et al. and the phase containing the analyte to be sensed. Thus, a vapor is not in direct contact with the electrode of Thackeray et al. The electrode of Thackeray et al. measures a change in redox at the sensor interface with the aqueous medium. Thackeray et al. do not measure a change in resistance.
- Yamato et al. teaches an electrode for electrochemical measurements. The electrode material of Yamato et al. is utilized in a "three-electrode cell containing 5 ml of 0.1 M KCl/0.1 M phosphate buffer (PB, pH 7.5) solution." (see page 232, §2.4 "Measurements"). As such the Yamato et al. electrodes have only a single conductive lead and measure a

change in redox at the electrode interface with the aqueous medium.

- Naarmann also teaches electrochemical systems. For example, Naarmann teaches that the electrochemical polymer material can be used as an electrode or electrodes in electrochemical storage cells (see English Abstract).
- Li (Materials Research Society Symposium Proceedings, 1995) also teaches electrochemical electrodes (i.e., sensor that comprise a single conductive lead). For example, at page 583-584, Li shows the use of a PANI-Pd film as an electrode (e.g. a cathode/anode) in an electrochemical cell. Li does not teach or suggest a sensor comprising two conductive leads that undergo a measurable change due to adsorption or absorption of an analyte.

Applicants respectfully submit that Casella, Thackeray, Yamato, Naarmann, and Li are *fundamentally different* sensor systems. One of ordinary skill in the art would not look to these sensor systems in developing a conductimetric (chemoresistive-type) sensor as claimed. The claims do not require such a charger transfer system and thus can sense analytes that the electrochemical approach cannot, and can do so in contact with liquids or other ambient like gases that do not support electrochemical reactions.

Thus, because of the fundamentally different measurements and reactivity of the two different types of sensors, one of ordinary skill in the art would not expect materials found in electrochemical systems to be capable of adsorbing and/or absorbing analytes to provide a measurable change between two conductive leads separated by the sensing area. Accordingly, one of skill in the art would not combine the electrochemical



sensor references with those teaching chemoresistive-type sensors.

**C. No Suggestion Or Motivation For Combination Of References.**

The rejection maintains the combination of conductimetric sensors with amperometric-electrochemical sensors even in view of the fundamental differences in structure and function and further in view of teachings in the art that teach away from the combination. As the CAFC stated in *ACS Hospital Systems Inc. v. Montefiore Hospital*, 221 USPQ 929, 933 (1984):

Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. Under section 103, teachings of references can be combined only if there is some suggestion or incentive to do so.

Furthermore, in *In re Gordon*, 221 USPQ 1125, 1127 (Fed.Cir. 1984), citing *In re Sernaker*, 217 USPQ 1, 6-7 (Fed. Cir. 1983) and *In re Imperato*, 179 USPQ 730, 732 (CCPA 1973):

The mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification.

Sestak (of record, but not prior art to Applicants' invention) actually teaches away from electrochemical sensors:

Conducting polymer-based sensors utilize electrochemical methods for detection, wherein the polymer acts as an electrode, or alternatively, they are based on simple resitometric detection. *The former can have the disadvantage of poor stability due to polymer degradation, usually caused by over-oxidation occurring during electrochemical cycling.*

(See page 118, 2<sup>nd</sup> full paragraph under the "Introduction"; emphasis added). Thus, to maintain the pending §103 rejection,

the teachings in the field of sensors and sensor systems must be disregarded. Applicants submit that there is no suggestion in any of the references for the proposed combination. In addition, the Sestak and Barisci references actually teach away from the combination.

Respectfully, the rejection has ignored the factual teachings of record and maintained a combination that is not supported by those of skill in the art. For example, the current rejection combines polymer sensors (Gibson) with amperometric-electrochemical sensors to arrive at, for example, polymer-inorganic sensors that are not electrochemical in nature. This combination of references is maintained even when the teachings of record indicate (1) that electrochemical sensors and polymers have poor stability and (2) are ineffective for many purposes. Applicants submit that the motivation taught by the references of record would be to not combine the references but rather would be to avoid such combinations. Applicants submit that there is no desirability to combine the references as clearly indicated by Sestak and Barisci (as discussed in more detail below).

**D. The Application of the Conducting Polymer Films to Gibson's Conductimetric Sensor System would not be Obvious to One of Ordinary Skill in the Art.**

The rejection, page 11, lines 19-20 of the Office Action mailed April 20, 2004 (Paper No. 35), alleges that one of ordinary skill in the art would have looked to electrochemical sensors for improvements in chemoresistive sensors. At page 3, 1<sup>st</sup> full paragraph of the same Office Action, Barisci allegedly describes a connection between amperometric-electrochemical

(i.e., "current measuring techniques") and conductimetric techniques that would have been recognized by one of ordinary skill. The basis for this allegation is that Barisci allegedly describes analytes interacting with conductive polymers to modify current flow as a function of applied potential.

Applicants respectfully disagree with these contentions and further submit that Barisci provides further support for Applicants' contention that the application of amperometric-electrochemical electrode materials to conductimetric sensors would not be obvious to one of ordinary skill in the art.

In amperometric-electrochemical sensors, the resistance of the electrode body is preferably not sensed at all. Rather, charge flow across the electrode/solution interface is sensed. While the resistance of the electrode body is determined by the composition and arrangement of the electrode body, charge flow across the electrode/solution interface is determined by a variety of other factors, including the capacitance between the electrode and the solution and the availability of electronic states at the electrode surface that can participate in charge transfer with species in the solution.

Barisci acknowledges the distinction between amperometric-electrochemical sensors and conductimetric sensors throughout his paper. The portion of Barisci devoted to amperometric-electrochemical sensors describes reduction/oxidation (Redox) reactions involving solvated ions and electron-transfer reactions for determining the presence of metal ions or small organic molecules. On the other hand, the portion of Barisci devoted to conductimetric sensors describes resistance changes in the polymer itself.

In Barisci, the distinction between amperometric-electrochemical sensors and conductimetric sensors is also explicitly acknowledged when Barisci describes the impact of counterions from the analyte on the different types of sensors. In discussing amperometric-electrochemical sensors, Barisci describes that the oxidation or reduction of the polymer backbone is influenced by certain counterion  $A^-$  from the analyte. As illustrated in FIG. 3 of Barisci, a counterion  $A^-$  can transfer across the electrode/solution interface to bind with cationic polypyrrole. It is this current flow across the electrode/solution interface that is sensed in Barisci's amperometric-electrochemical sensors.

On the other hand, when Barisci describes conductimetric sensors, Barisci indicates that the resistance of the polymer is impacted by the exchange of counterions with those in solution. In such ion exchanges, there is no net current flow across the electrode/solution interface. Rather, a first anion (e.g.,  $A^-$ ) simply exchanges with a second anion (e.g.,  $B^-$ ). Depending upon the relative properties of the exchanged counterions (such as, e.g., the relative electronegativity and electronic states), the conductivity of the polymer itself may change. This conductivity change is detected in Barisci's conductimetric sensors.

In light of this distinction between Barisci's amperometric-electrochemical sensors and Barisci's conductimetric sensors, Applicants respectfully submit that one of ordinary skill would not have looked to materials used in amperometric-electrochemical sensors to improve conductimetric sensors. There is simply no reason to believe that the conductivity of a material will, in any way, somehow be related

to the transfer of charge at the interface of the material with a solution. Furthermore, based upon Barisci, the ion exchange capability of a material is not indicative that a composite comprising the material would absorb, adsorb or imbibe an analyte to cause a change in conductive when a current is applied across the composite material.

Further, the materials chosen to act as electrodes in amperometric-electrochemical sensors are selected based, at least in part, on the fact that their conductivity is not "sensed" in the amperometric-electrochemical sensor. This "invisibility" is inapposite to application in the sensing area of a conductimetric sensor. Indeed, "sensing" the conductive properties of amperometric-electrochemical sensor electrodes will render the electrodes unfit for their intended use in amperometric-electrode sensors. Furthermore, it is not the case at all that materials that are good electrochemical detectors will make good chemiresistors so obviousness does not flow from one to the other. An example of this is the use of ferrousine modified enzymatic sensors to detect glucose. These are good electrochemical sensors but make completely useless chemiresistors because in fact they are electronically resistive to DC current in both forms. Thus one of skill in the art would not look to amperometric-electrochemical sensors as chemiresistors even if they function well for the intended electrochemical sensing purpose.

Because of the fundamentally different measurements and reactivity of the two different types of sensors one of skill in the art would not look to a system that requires redox reactions and single conductive leads in developing sensors that measure a resistance between two conductive leads separated by the sensing

area. One of skill in the art would not combine the electrochemical sensor references (e.g., Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li) with those teaching chemoresistive-type sensors. It would not be inherent or obvious that the sensor material used in electrochemical systems would function in the sensor systems as set forth by Applicants. For example, a pH electrode is an electrochemical sensor system. One of skill in the art would not look to or expect that a pH sensor can be combined with other references to arrive at Applicants' invention. Furthermore, Applicants submit that materials used in electrochemical sensor systems are not required to be conductive (i.e., such systems utilize materials that are non-conductive), which is contrary to Applicants' claimed invention.

Applicants therefore respectfully submit that there is no suggestion or motivation to combine the cited references in the manner suggested by the Examiner. Furthermore, the references before the Examiner actually teach away from the combination.

**E. None of the Cited References Alone or in Combination Describe or Suggest a Sensing Area that Provides an Electrical Path Through a Conductive Organic Material and a Compositionally Different Conductive Material.**

With the exception of independent claim 127, each and every pending independent claim recites a "sensing area". The sensing area provides an electrical path through a conductive organic material and a conductive material compositionally different than the conductive organic material. In claim 152, the sensor response varies according to the presence of an analyte in contact with the electrical path through the sensing area. In

claims 98, 104, 105, 106, 126, an apparatus detects a change in the sensing area.

Applicants respectfully submit that, even if the cited references were to describe or suggest a composite of a conductive organic material and a conductive material compositionally different than the conductive organic material (which they do not), if any such composite were used as an electrode in wet-cell, amperometric-electrochemical sensors, such a composite would not be a "sensing area" as recited in Applicants' claims.

Amperometric-electrochemical sensors operate by measuring the flow of charge (i.e., the current) across the electrode/solution interface. As described at the last paragraph on pg. 307 of Barisci, the rate of charge transfer across the electrode/solution interface is determined by a number of factors including the capacitance between the electrode and the solution and the availability of electronic states at the electrode surface that can participate in charge transfer with species in solution.

Since amperometric-electrochemical sensors rely upon measurement of the rate of charge transfer across the electrode/solution interface to identify species in solution, the "sensing area" of an amperometric sensor is the analyte/solution interface itself. Although the composition of the electrode impacts charge transfer (e.g., by determining which electronic states are present in the solution), the electrode itself is not part of the sensing area.

Indeed, for an amperometric-electrochemical sensor to operate properly, the body of the electrode must generally be "invisible" to the sensing device. In amperometric-

electrochemical sensors, the body of the electrode is in electrical series with the electrode/solution interface. In other words, a charge will flow both through the body of the electrode and across the electrode/solution interface. If the resistance of the body of the electrode is comparable to the resistance of the electrode/solution interface, then charge flow will be limited by both the body of the electrode and at the electrode/solution interface. If the resistance of the body of the electrode is higher, charge flow will essentially be limited by the body of the electrode alone.

In these situations (i.e., when the resistance of the body of the electrode is "sensed"), amperometric-electrochemical sensors *will not function* as intended. In particular, the measurements made by the amperometric-electrochemical sensor will not reflect charge transfer across the electrode/solution interface. Rather, the measurements will reflect the electrical conduction of the body of the electrode. Such a "sensing" of the electrode body by the current sensor would thus render the electrode body *unfit for its intended purpose* in the amperometric-electrochemical sensor.

Applicants therefore respectfully submit that composites of conductive polymer films and conductive materials compositionally different than the films used as electrodes in wet-cell, amperometric-electrochemical sensors are not "sensing areas" as claimed. Moreover, Applicants submit that usage of such composites as sensing areas would render the composites unfit for their intended purpose in amperometric-electrochemical sensors, namely to provide low-resistance conductors that provide certain electronic states to the sensing electrode/solution interface.



**III. The Combination Of References Do Not Teach Each And Every  
Element Of Applicants' Claimed Invention**

Applicants now turn to the numerous and varied combinations. The Office Action mailed April 20, 2004 (Paper No. 35) indicates at page 11, lines 16-17 that Gibson is not anticipatory of Applicants' claimed invention and thus is combined with a number of references in an attempt to overcome the deficiencies of Gibson.

Gibson, as the primary reference, admittedly does not teach or suggest a composition in which the two conductive materials are mixed together to form a single sensing area or as an array having sensors that are not organic polymer based (see, e.g., the Office Action mailed April 20, 2004 (Paper No.35) at page 3, lines 2-5). Furthermore, although the Office Action construes "two monomers" as being two conductive materials, such monomers are not "compositionally different" materials as recited in Applicants' claims.

The secondary references (e.g., Casella, Thackeray, Yamato, Naarmann, Li, Sakaguchi, Wampler, Breheret, Mifsud I and II, Moy, or Persaud) are applied in combination with Gibson for the alleged teaching or suggestion that the secondary references show that the claimed composites are known as gas sensors or would have been expected to form a sensing area that would have enhanced properties relative to the conducting polymers used by Gibson (see, the Office Action mailed October 23, 2002 (Paper No.24) at page 12, paragraph 8).

Applicants respectfully submit (1) that there is no suggestion or motivation to combine the references particularly where the references teach electrochemical sensors (as described

above), and (2) that the combination fails to teach or suggest each and every element found in Applicants' claimed invention.

With respect to Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li, Applicants maintain that Casella, Thackeray, Yamato, Galal, Naarmann, and Li are fundamentally different sensor systems and one of skill in the art would not look to these sensor systems in developing a chemoresistive-type sensors as disclosed and claimed by Applicants. Even if there was some motivation to combine, which there is not, the references cited do not teach or suggest each and every element of Applicants' claimed invention. For example, the electrochemical systems of the cited references utilizes a single conductive lead attached to the sensing material, not two leads as recited in Applicants' claims.

Furthermore, the electrochemical systems are based upon redox reactions, which are fundamentally different than resistance measurements as recited in Applicants' claims. The electrochemical sensors do not measure changes "across" the sensor material as recited in Applicants' claimed invention.

**A. The Cited References Either Alone Or In Combination Do Not Teach Or Suggest Each And Every Element Of Applicants' Claimed Invention**

Applicants' submit that Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li are directed to amperometric-electrochemical sensor systems and thus should not be combined with Gibson. However, even if these fundamentally different sensor systems are combined with Gibson, the combination fails to teach or suggest each and every element of Applicants' claimed invention. The references fail to teach or suggest

resistance measurements and a sensing area separated by and in communication with two conductive leads. Accordingly, Casella, Thackeray et al., Yamato et al., Galal, Naarman, and Li do not render the claims obvious for at least the foregoing reasons.

**1. Gibson And Casella Do Not Teach Or Suggest Applicants'  
Claimed Invention**

Gibson fails to teach or suggest Applicants' claims for the reasons set forth above. The Casella reference teaches an electrochemical sensor as described above and thus one of skill in the art would not look to Casella to overcome the deficiencies of Gibson. Casella teaches a sensor layered with polyaniline. The Casella sensor measurements are done using an electrochemical system. For example, Casella teaches at page 218, §2.2 "Apparatus", that "[c]yclic voltammetry (CV) was done in a three-electrode cell using a Cu-PANI working electrode, a saturated calomel reference electrode (SCE) . . . and a platinum foil counter electrode." As such, the Casella sensor has only a single conductive lead and measures redox reactions upon the sensor material. The Casella reference does not teach or suggest two conductive leads or that a vapor is in direct conduct with a sensor. The combination of Gibson, which does not teach a single sensing area between two conductive leads and which does not teach a sensing area of two compositionally different conductive materials, is combined with Casella, which also does not teach a single sensing area comprising two compositionally different materials between two conductive leads. Thus, both Gibson and Casella fail to teach or suggest the following element of Applicants' claims:

. . . alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material, and wherein the sensing area is in direct contact with a vapor comprising an analyte to be detected. . .

Accordingly, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention. The combination does not teach or suggest the elements of Applicants' claimed invention (e.g., two conductive leads, a sensing area, a sensing area comprising two compositionally different materials, and changes of resistance across the sensor).

## **2. Gibson And Thackeray Do Not Teach Or Suggest The Claim**

Gibson fails to teach or suggest Applicants' claims for the reasons set forth above. Thackeray teaches an electrochemical sensor as described above and thus one of skill in the art would not look to Thackeray to overcome the deficiencies of Gibson. The chemistry that produces a signal in Thackeray is electrochemical in nature, requiring an electrolyte media containing ions to maintain a potential on the sensor. The electrochemical reaction involves a transfer of faradic charge and associated ions between the sensor of Thackeray and the phase containing the analyte to be sensed. Thus, a vapor is not in direct contact with the sensor of Thackeray. In the Office Action mailed October 23, 2002, the rejection addresses

Applicants' arguments by stating that, "The Thackeray reference is clearly sensitive to gases - hydrogen and oxygen." (See, e.g., page 12 of the October 23, Office Action). Applicants respectfully submit that Thackeray is sensitive to hydrogens and oxygen atoms because REDOX reactions are the basis of how the sensor system of Thackeray works. Applicants respectfully submit that the sensors of Thackeray et al. would cease to function if they were directly contacted with a vapor containing an analyte because the Thackeray et al. sensors would be unable to perform REDOX reactions. Thus, the proposed combination would render Thackeray unsuitable for its intended purpose.

Thackeray does not teach or suggest that an analyte is capable of adsorbing or absorbing to the sensor material. The sensor material of Thackeray is sensitive to changes in electrons in the electrolyte medium (i.e., oxidation or reduction due to the presence of hydrogen or oxygen). Thus, a vapor cannot be in direct contact with the sensor of Thackeray et al. for the sensor of Thackeray et al. to function as intended.

The combination of Gibson, which does not teach a single sensing area between two conductive leads comprising compositionally different conducting materials, is combined with Thackeray, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. Thus, both Gibson and Thackeray fail to teach or suggest the following element of Applicants' claims:

. . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in

electrical communication with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

**3. Gibson And Yamato Do Not Teach Or Suggest Applicants' Claimed Invention**

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Yamato et al. teach sensors having on their surface glucose oxidase (GOD) (see, Yamato at page 235, first column, section 3.2). Applicants submit that an enzyme linked electrochemical (oxidation reduction) system is far removed from Applicants' claimed invention and thus one of skill in the art would not look to Yamato to overcome the deficiencies of Gibson. Furthermore, such enzyme linked materials are not suitable for chemiresistive measurements. Yamato et al. teaches a sensor for electrochemical measurements. The sensor material of Yamato et al. is utilized in a "three-electrode cell containing 5 ml of 0.1 M KCl/0.1 M phosphate buffer (PB, pH 7.5) solution." (see page 232, §2.4 "Measurements"). As such the Yamato et al. sensor has only a single conductive lead and measures a change in redox at the sensor interface with the electrolyte medium. Yamato et al. do not teach or suggest two conductive leads attached to a sensor as recited in Applicants' claims. Yamato

et al. do not teach or suggest resistivity measurements as recited in Applicants' claims.

Applicants submit that even if there were motivation to combine Gibson and Yamato, which there is not, at most the combination would teach the use of immobilized enzymes (very different than conductive materials) on a polymer material for use in an electrochemical system (e.g., having only a single conductive lead). The combination of Gibson, which does not teach a single sensing area between two conductive leads comprising compositionally different conductive materials, is combined with Yamato, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. As such Yamato in combination with Gibson would fail to teach or suggest:

. . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in electrical communication with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

#### **4. Gibson And Naarmann Do Not Teach Or Suggest Applicants' Claimed Invention**

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Naarmann when

combined with Gibson fails to teach or suggest Applicants' claimed invention.

Naarmann teaches that the electrochemical polymer material can be used as an electrode or as sensor electrodes in electrochemical storage cells (see English Abstract). The combination of Gibson, which does not teach a single sensing area between two conductive leads comprising compositionally different conductive materials, is combined with Naarmann, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. Thus, both Gibson and Naarmann fail to teach or suggest the following element of Applicants' claims:

. . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

In addition, Gibson in combination with Naarmann also fails to teach or suggest the materials that can make up the compositionally different conductive material, namely,

. . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

Accordingly, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.



**5. Gibson And Li Do Not Teach Or Suggest Applicants' Claimed  
Invention**

Gibson fails to teach or suggest the claim for the reasons set forth above. Li teaches electrochemical sensors (i.e., sensors that have a single conductive lead). For example, at page 583-584, Li shows the use of a PANI-Pd film as an electrode (e.g. a cathode/anode) in an electrochemical cell. Li does not teach or suggest a sensor comprising two conductive leads that undergo a measurable change due to adsorption or absorption of an analyte. The combination of Gibson, which does not teach a single sensing area between two conductive leads comprising compositionally different conductive materials, is combined with Li, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. Thus, both Gibson and Li fail to teach or suggest the following element of Applicants' claims:

. . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, the combination cannot render Applicants' claim obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

**6. Gibson And Sakaguchi Do Not Teach Or Suggest Applicants'  
Claimed Invention**

Gibson fails to teach or suggest Applicants' claims invention for the reasons set forth above. Sakaguchi also teaches electrode (e.g. a cathode/anode) reactions (see, e.g., page 7, line 11-12 of the Final Office Action mailed May 7, 2003 (Paper No. 29)). Such electrode reactions are used in electrochemical cells. Sakaguchi does not teach or suggest a sensor comprising a sensing area between two conductive leads that undergoes a measurable change due to adsorption or absorption of an analyte. The combination of Gibson, which does not teach a single sensing area between two conductive leads comprising compositionally different conductive materials, is combined with Sakaguchi, which also does not teach a single sensing area between two conductive leads. Thus, both Gibson and Sakaguchi fail to teach or suggest the following element of Applicants' claims:

. . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

**7. Gibson And Stetter Do Not Teach Or Suggest Applicants'**

**Claimed Invention**

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. The Examiner combines Stetter with Gibson, because "The Stetter reference shows the interchangeability of carbon black and metal particles as components in a polymer sensor." (See, e.g., Page 10, last line of the Office Action mailed September 29, 2003). Applicants submit that the interchangeability of carbon black and metal is consistent and cumulative with the Harsanyi reference filed September 5, 2003. Stetter teaches conductive elements in combination with insulating polymers. Thus, the addition of Stetter in the multiple combinations is cumulative to the references of record. Stetter does not teach or suggest two compositionally different conductive materials. The combination of Gibson with Stetter fails to teach or suggest a sensing area comprising a conductive polymer and a compositionally different conductive material between two conductive leads.

**8. Gibson And Wampler Do Not Teach Or Suggest Applicants'**

**Claimed Invention**

Gibson fails to teach or suggest Applicants' claimed invention for the reasons set forth above. Gibson is further combined with Wampler in an attempt to overcome the deficiencies of Gibson. Wampler teaches that polypyrrole composites are useful for eliminating Cr(VI) in the environment by reducing Cr(VI) to Cr(III) (see, e.g., page 1820). Wampler, however, does not teach or suggest composites as chemoresistive-type sensors comprising a sensing area separating two electrical

leads that measure a change in the electrical properties of the composite between the two leads when contacted with an analyte. Thus, the combination of Gibson, which does not teach a single sensing area between two conductive leads comprising compositionally different conductive materials, is combined with Wampler, which also does not teach a single sensing area comprising two compositionally different conductive materials between two conductive leads. The combination of Gibson and Wampler fails to teach or suggest:

. . .alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Accordingly, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claims.

**9. Gibson And Breheret Do Not Teach Or Suggest Applicants' Claimed Invention**

Gibson is also combined with Breheret. Breheret mentions two different types of sensors: 1) semiconductor gas sensors, and 2) conducting polymer sensors. Neither of the two types of sensors is described nor does Breheret teach or suggest the composition of the sensors. The only description found in the Breheret reference is to the "AROMASCAN A20S Device". Applicants respectfully submit that the Breheret reference is not enabled for any teaching relied upon by the Examiner to

render Applicants' invention obvious. For example, there is no teaching or suggestion in Breheret that overcomes the deficiencies of Gibson. In other words, the combination fails to teach or suggest:

. . .a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

The combination fails to teach or suggest:

. . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

Furthermore, Applicants submit that the combination fails to teach or suggest a compositionally different material:

. . .wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases. . .

However, even if the Breheret reference was enabled, Breheret teaches away from Applicants' claimed invention due to the teaching in Breheret that polymer films are less sensitive than semiconductive gas sensors. This is in contrast to the unexpected finding presented in Applicants' disclosure which teach that the conductive organic polymers and compositionally different conductive material composites have orders of magnitude better sensitivity than other conventional polymer

composites to amine analytes. Accordingly, the combination of Gibson and Breheret fails to teach or suggest each and every element of Applicants' claimed invention.

**10. Gibson And Mifsud I and II Do Not Teach Or Suggest  
Applicants' Claimed Invention**

Gibson is also combined with Mifsud I and II. Mifsud I and II also do not teach or suggest the composition of the sensors. Applicants respectfully submit that the Mifsud reference is not enabled for any teaching relied upon by the Examiner to render Applicants' invention obvious. For example, there is no teaching or suggestion in Mifsud I and II that overcomes the deficiencies of Gibson. In other words, the combination fails to teach or suggest:

. . .a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

The combination fails to teach or suggest:

. . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

Furthermore, Applicants submit that the combination fails to teach or suggest a compositionally different material:

. . .wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases. .

The only teaching that would allow a person skilled in the art to have the faintest idea as to the composition of the sensors is found in Mifsud I at column 1, lines 53-64, which teaches that the conductive polymer sensors "have a film made of a conductive polymer sensitive to the molecules of odorous substances." Mifsud fails to teach or suggest a sensing area of a conductive organic polymer and a compositionally different conductive material.

Accordingly, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

**11. Gibson And Moy Do Not Teach Or Suggest Applicants' Claimed Invention**

Gibson is also combined with Moy. Moy also does not teach or suggest the composition of the sensors. Applicants respectfully submit that the Moy reference is not enabled for any teaching relied upon by the Examiner to render Applicants' invention obvious. For example, the Moy reference does not teach or suggest a composite of a metal oxide and a polymer (as suggested by the Examiner; see, e.g. page 9 of Paper No: 29). Rather, Moy, at most, teaches an array made up of one or more metal oxide sensors and one or more polymer sensors. There is no teaching or suggestion in Moy that overcomes the deficiencies of Gibson. In other words, the combination fails to teach or suggest:

. . .a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

The combination fails to teach or suggest:

. . .selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof. . .

Furthermore, Applicants submit that the combination fails to teach or suggest a compositionally different material:

. . .wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases. .

Applicants respectfully submit that Moy fails for the same reasoning as presented for Breheret and Mifsud I and II above. The Moy reference does not teach or suggest materials used in the "polymer sensors". Moy teaches at most an array of (1) metal oxide gas sensors and (2) sensors having a conductive polymer. Moy does not teach or suggest a sensor comprising a composite having both a conductive organic material and a compositionally different conductive material. Nor does Moy teach or suggest an array of sensors, wherein at least one sensor comprises a material having both a conductive organic material and a compositionally different conductive material. Thus, the combination of Gibson and Moy does not teach or suggest Applicants' claimed invention.



Accordingly, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

**12. Gibson And Persaud Do Not Teach Or Suggest Applicants'  
Claimed Invention**

Gibson is addressed above and is deficient (as admitted by the Examiner) in that Gibson fails to teach or suggest a sensing area or a composite of a conducting organic material and a conducting material that is compositionally different. Applicants respectfully submit that Persaud fails for the same reasoning as presented for Breheret, Mifsud I and II, and Moy, above. Persaud teaches as most a sensor having an organic polymeric semiconductor such as polyindole (see, e.g., page 4, line 2). Persaud does not teach or suggest a sensor having a sensing area comprised of a combination of a conductive organic material and a compositionally different conductive material. Gibson in combination with Persaud fails to teach or suggest:

. . .a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material. . .

Nor does the combination teach or suggest an array of sensors, wherein at least one sensor comprises a material having both a conductive organic material and a compositionally different conductive material. Thus, the combination of Gibson

and Persaud does not teach or suggest Applicants' claimed invention. Accordingly, the combination cannot render Applicants' invention obvious as the combination does not teach or suggest each and every element of Applicants' claimed invention.

#### **IV. Unexpected Results**

Applicants' claimed invention provides unexpected results that must be considered in addressing a rejection for obviousness. Applicants respectfully submit that it is impermissible to ignore the advantages, properties, utilities and unexpected results that flow from the claimed invention; they are part of the invention as a whole. *In re Wright*, 848 F.2d 1216, 6 USPQ2d 1959 (Fed. Cir. 1988); *In re Sernaker*, 702 F.2d 989, 217 USPQ 1 (Fed. Cir. 1983).

The Applicants respectfully direct the Board to, for example, Figure 4 and page 15, lines 12-18 of Applicants' specification, which recite and demonstrate that the "response is orders of magnitude larger than any seen from sensors prepared from insulating polymer-carbon black composite films." The Board is also directed to page 82, lines 20-23, which states, "Sensors prepared from emeraldine . . . consistently exhibit a response to amines which is several orders of magnitude larger than any observed from conventional polymer-carbon black sensors."

As stated in *Application of Orfeo*, 440 F.2d 439, 442 (CCPA 1971), :

We think that this is one of those cases where even though the claimed invention involves the use of a known compound in a known process it is still unobvious to one of ordinary skill in the art because

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of the new and unexpected results and effects achieved.

The Board is asked to take into account the teachings of, for example, Breheret and Moy, which actually teaches away from Applicants' claimed invention by stating that semi-conductor gas sensors are better at detection than polymer based sensors. Because the Breheret and Moy references actually teach away, one of skill in the art would not be motivated to combine the teachings as suggested in the Office Action.

The brief fee of \$340 is enclosed and a \$110 check for the Petition for Extension of Time. Please apply any other charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: 11/5/04

  
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### Appendix of Claims

98. A sensor, comprising:

at least two conductive leads;

a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material, and wherein the sensing area is in direct contact with a vapor comprising an analyte to be detected, wherein the compositionally different conductive material is selected from the group consisting of an inorganic conductor, a carbon black, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, a superconductor, or a combination thereof and wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases; and

an apparatus in electrical communication with the conductive leads for detecting a change in the sensing area between the at least two conductive leads when contacted with an analyte.

99. The sensor according to claim 98, wherein the conductive organic material is selected from the group consisting of a polyaniline, an emeraldine salt of polyaniline, a polypyrrole, a polythiophene, a polyEDOT, and derivatives thereof.

100. The sensor according to claim 98, wherein the compositionally different conductive material is carbon black.

101. The sensor according to claim 98, further comprising an insulator or plasticizer.

102. The sensor of claim 98, wherein the conductive organic material is an emeraldine salt of polyaniline and the compositionally different conductive material is carbon black.

103. The sensor of claim 98, wherein the conductive organic material is a doped polyaniline and the compositionally different conductive material is carbon black.

104. A sensor, comprising:  
at least two conductive leads;  
a sensing area comprising alternating interpenetrating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between and in contact with the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material, and wherein the sensing area is in direct contact with a vapor comprising an analyte to be detected, wherein the compositionally different conductive material is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, or a superconductor, or a

combination thereof and wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases; and

an apparatus in electrical communication with the conductive leads for detecting a change in the sensing area between the at least two conductive leads when contacted with an analyte.

105. A sensor, comprising:

at least two conductive leads;

a sensing area comprising dispersed regions of a conductive organic material and a conductive material compositionally different than the conductive organic material wherein the dispersed regions provide interpenetrating regions of the conductive organic material and a conductive material compositionally different than the conductive organic material, the sensing area disposed between and in contact with the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material, and wherein the sensing area is in direct contact with a vapor comprising an analyte to be detected, wherein the compositionally different conductive material is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, or a superconductor, or a combination thereof and wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases; and

an apparatus in electrical communication with the conductive leads for detecting a change in the sensing area between the at least two conductive leads when contacted with an analyte.

106. A sensor, comprising:  
at least two conductive leads;  
a sensing area comprising alternating interpenetrating regions of a polyaniline or an emeraldine salt of polyaniline and a conductive material compositionally different than the polyaniline or emeraldine salt of polyaniline disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the alternating interpenetrating regions of polyaniline or emeraldine salt of polyaniline and the conductive material compositionally different than the polyaniline or emeraldine salt of polyaniline; and

an apparatus in electrical communication with the conductive leads for detecting a change in the sensing area between the at least two conductive leads when contacted with an analyte.

107. The sensor of claim 106, wherein the conductive material compositionally different than the polyaniline or emeraldine salt of polyaniline is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, an oxidized metal, a superconductor, and any combination thereof.

108. A sensor array comprising:  
a plurality of sensors, wherein at least one sensor comprises:  
at least two conductive leads;  
a sensing area comprising alternating interpenetrating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between and in contact with the at least two conductive leads, wherein the sensing area provides an electrical path through the alternating interpenetrating regions of the conductive organic material and the regions of the compositionally different conductive material, wherein the sensing area is in direct contact with a vapor comprising an analyte to be detected, wherein the compositionally different conductive material is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, or a superconductor, or a combination thereof and wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases.

109. The sensor array according to claim 108, wherein the sensor array comprises a plurality of sensors each comprising regions of a conductive organic material and regions of a conductive material compositionally different than the conductive organic material wherein the conductive organic material of at least one sensor is different from the conductive organic material of at least one other sensor.



110. The sensor array according to claim 108, wherein the compositionally different conductive material is an inorganic conductor.

112. The sensor array according to claim 159, wherein the conductive organic material of one sensor of the plurality of sensors is compositionally different than at least one other sensor of the plurality of sensors.

113. The sensor array according to claim 108, wherein the conductive organic material is selected from the group consisting of a polyaniline, an emeraldine salt of polyaniline, a polypyrrole, a polythiophene, and a polyEDOT, and the conductive material compositionally different than the conductive organic material is selected from the group consisting of Ag, Au, Cu, Pt, carbon black, and AuCu.

114. The sensor array according to claim 108 or 113, further comprising a temperature control apparatus in thermal communication with at least one sensor.

115. The sensor array according to claim 108 or 113, further comprising an apparatus for detecting a change selected from the group consisting of resistance, conductance, impedance, and capacitance in the electrical properties of at least one sensor.

116. The sensor array according to claim 115, further comprising a temperature control apparatus in thermal communication with at least one sensor.

117. The sensor array according to claim 110, wherein the inorganic conductor is selected from the group consisting of Ag, Au, Cu, Pt, and AuCu.

118. The sensor array according to claim 108, wherein the compositionally different conductive material is carbon black.

119. The sensor array according to claim 108, wherein the compositionally different conductive material is an organic conductor.

120. The sensor array according to claim 108, wherein the conductive material compositionally different than the conductive organic material is a member selected from the group consisting of an organic conductor, an inorganic conductor, and a mixed inorganic/organic conductor.

121. The sensor array according to claim 108, wherein the conductive material compositionally different than the conductive organic material is a member selected from the group consisting of a metal, a metal alloy, a metal oxide, an organic complex, a superconductor, and a mixed inorganic/organic conductor.

122. The sensor array according to claim 108, wherein the compositionally different conductive material is a particle.

123. The sensor array according to claim 159, wherein the compositionally different conductive material of each of the sensors in the plurality of sensors comprises a conductive organic material.

126. A sensor array comprising:  
a plurality of sensors, wherein at least one sensor comprises:  
at least two conductive leads;  
a sensing area comprising alternating interpenetrating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material, wherein the sensing area is in direct contact with a vapor comprising an analyte to be detected, wherein the compositionally different conductive material is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor, and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal a metal alloy, a metal oxide, a superconductor, or a combination thereof, wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases; and  
a measuring apparatus electrically coupled to the at least two conductive leads for detecting a change in the sensing area when contacted with an analyte.

127. A sensor array comprising:

a plurality of sensors wherein at least one sensor comprises alternating interpenetrating regions of a conductive organic material and regions of a compositionally different conductive material wherein the sensors are in direct contact with a vapor comprising an analyte to be detected; and

means, electrically coupled to the plurality of sensors, for detecting a change in the plurality of sensors when contacted with an analyte.

128. A sensor array system comprising:

a plurality of sensors, wherein at least one sensor comprises:

at least two conductive leads;

a sensing area comprising alternating interpenetrating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between and in contact with the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material, wherein the sensing area is in direct contact with a vapor comprising an analyte to be detected, wherein the compositionally different conductive material is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, or a superconductor, or a combination thereof and wherein the inorganic conductor has an

electrical conductivity that decreases as the temperature increases;

a measuring apparatus that detects a change in the electrical properties of the at least one sensor, wherein at least one sensor is in communication with the measuring apparatus; and

a computer comprising a resident algorithm, wherein the computer processes the change in the electrical properties.

129. The sensor array system according to claim 128, wherein the measuring apparatus is an electrical measuring device.

130. The sensor array system according to claim 128, wherein the compositionally different conductive material is an inorganic conductor.

131. The sensor array system according to claim 128, wherein the plurality of sensors each comprise regions of a conductive organic material and regions of a conductive material compositionally different than the conductive organic material.

132. The sensor array system according to claim 131, wherein the conductive organic material of at least one sensor is different from the conductive organic material of at least one other sensor.

133. The sensor array system according to claim 131, wherein the conductive organic material of the plurality of sensors are compositionally the same.

134. The sensor array system according to claim 128, wherein the change in electrical properties is selected from the group consisting of impedance, conductance, capacitance, inductance, and resistance in the sensors.

135. The sensor array system according to claim 128, wherein the conductive organic material is selected from the group consisting of a polyaniline, an emeraldine salt of polyaniline, a polypyrrole, a polythiophene, and a polyEDOT, and the conductive material compositionally different than the conductive organic material is selected from the group consisting of Ag, Au, Cu, Pt, carbon black, and AuCu.

136. The sensor array system according to claim 128 or 135, further comprising a temperature control apparatus in thermal communication with at least one sensor.

137. The sensor array system according to claim 128 or 135, wherein the change in electrical properties is a change in an electrical impedance.

138. The sensor array system according to claim 137, further comprising a temperature control apparatus in thermal communication with at least one sensor.

139. The sensor array system according to claim 130, wherein the inorganic conductor is a member selected from the group consisting of Ag, Au, Cu, Pt, and AuCu.

140. The sensor array system according to claim 128, wherein the compositionally different conductive material is carbon black.

141. The sensor array system according to claim 128, wherein the compositionally different conductive material is an organic conductor.

142. The sensor array system according to claim 128, wherein the conductive material compositionally different than the conductive organic material is selected from the group consisting of an organic conductor, an inorganic conductor, and a mixed inorganic/organic conductor.

143. The sensor array system according to claim 128, wherein the conductive material compositionally different than the conductive organic material is selected from the group consisting of a metal, a metal alloy, a metal oxide, an organic complex, a superconductor, and a mixed inorganic/organic conductor.

144. The sensor array system according to claim 128, wherein the compositionally different conductive material is a particle.

145. The sensor array system according to claim 128, wherein each of the sensors comprises a conductive organic material.

146. The sensor array system according to claim 128, wherein the conductive organic material is an organic polymer.

147. The sensor array system according to claim 128, wherein the resident algorithm is a member selected from the group consisting of principal component analysis, Fisher linear analysis, neural networks, genetic algorithms, fuzzy logic, pattern recognition, and combinations thereof.

148. A system for identifying a microorganism, the system comprising:

- a measuring apparatus;

- a sensor array comprising a plurality of sensors in communication with the measuring apparatus, wherein at least one sensor comprises:

- at least two conductive leads;

- a sensing area comprising alternating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between and in electrical communication with the at least two conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material, and wherein the sensing area is in direct contact with a vapor comprising a biomarker to be detected; and

- a computer comprising a resident algorithm;

- wherein the measuring apparatus is capable of detecting a response from each sensor in the array wherein the responses are indicative of the presence of a biomarker of a microorganism and the computer is capable of assembling the responses into a



response profile whereby the computer associates the response profile indicative of the biomarker with a microorganism for microorganism identification.

149. The system for identifying a microorganism in accordance with claim 148, wherein the resident algorithm of the computer is a member selected from the group consisting of principal component analysis, Fisher linear analysis, neural networks, genetic algorithms, fuzzy logic, pattern recognition, and combinations thereof.

150. The system for identifying a microorganism in accordance with claim 148, further comprising the steps of:  
providing an information storage device coupled to the measuring apparatus; and  
storing information in the information storage device.

151. The system for identifying a microorganism in accordance with claim 148, wherein the measuring apparatus includes a digital-analog converter.

152. A system for detecting an analyte in a sample, comprising:  
a substrate having a plurality of sensors wherein at least one sensor comprises:  
at least two conductive leads;  
a sensing area comprising alternating interpenetrating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between, and in contact with, the at least two

conductive leads, wherein the sensing area provides an electrical path through the regions of the conductive organic material and the regions of the compositionally different conductive material such that the at least one sensor provides a response that varies according to the presence of an analyte in contact with it, wherein the sensing area is in direct contact with a vapor comprising an analyte to be detected, wherein the compositionally different conductive material is selected from the group consisting of an organic conductor, an organic complex, an inorganic conductor and a mixed inorganic/organic conductor, wherein the inorganic conductor is a metal, a metal alloy, a metal oxide, or a superconductor, or a combination thereof and wherein the inorganic conductor has an electrical conductivity that decreases as the temperature increases;

a detector operatively associated with the plurality of sensors, for measuring the response of the plurality of sensors when contacted with the sample;

a sample delivery unit for delivering the sample to be tested to the plurality of sensors; and

an information storage and processing device configured to store an ideal response for a predetermined analyte and to compare the response of the plurality of sensors with the stored ideal response, to detect the presence of the analyte in the sample.

153. The system in accordance with claim 152, wherein the information storage and processing device is configured to store ideal responses for a plurality of predetermined analytes; and

the information storage and processing device further is configured to compare the response of the plurality of sensors

with the plurality of stored ideal responses, to detect the presence of each analyte in the sample.

154. The system in accordance with claim 152, wherein the sample is a liquid and the sample delivery unit comprises:

a flow passage interconnecting the substrate comprising the plurality of sensors with a mixture containing the liquid;

a gas-permeable, liquid-impermeable shield interposed in the flow passage; and

a device for extracting vapor from the liquid and for delivering the extracted vapor along the flow passage to the substrate comprising the plurality of sensors via the flow passage.

155. The system in accordance with claim 152, wherein the sample is gaseous and the sample delivery unit comprises:

a gas flow passage; and

a pump for pumping the gaseous sample to the substrate comprising the plurality of sensors via the gas flow passage.

156. The system in accordance with claim 152, wherein the sample is a vapor extracted from a solid and the sample delivery unit comprises:

a vapor flow passage; and

a pump for pumping the vapor extracted from the solid to the substrate comprising the plurality of sensors via the vapor flow passage.

157. The system in accordance with claim 152, wherein the detector detects a member selected from the group consisting of

electromagnetic energy, optical properties, resistance, capacitance, inductance, impedance, and combinations thereof.

158. The system in accordance with claim 152, wherein at least one other sensor in the plurality of sensors comprises a member selected from the group consisting of a surface acoustic wave sensor; a quartz microbalance sensor; a conductive composite; a chemiresistor; a metal oxide gas sensor; a conducting polymer sensor; a dye-impregnated polymer film on fiber optic detector; a polymer-coated micromirror; an electrochemical gas detector; a chemically sensitive field-effect transistor; a carbon black-polymer composite; a micro-electro-mechanical system device; and a micro-opto-electro-mechanical system device.

159. The sensor array of claim 108, wherein the plurality of sensors comprise at least two conductive leads and a sensing area comprising alternating interpenetrating regions of a conductive organic material and a conductive material compositionally different than the conductive organic material disposed between and in electrical communication with the at least two conductive leads.

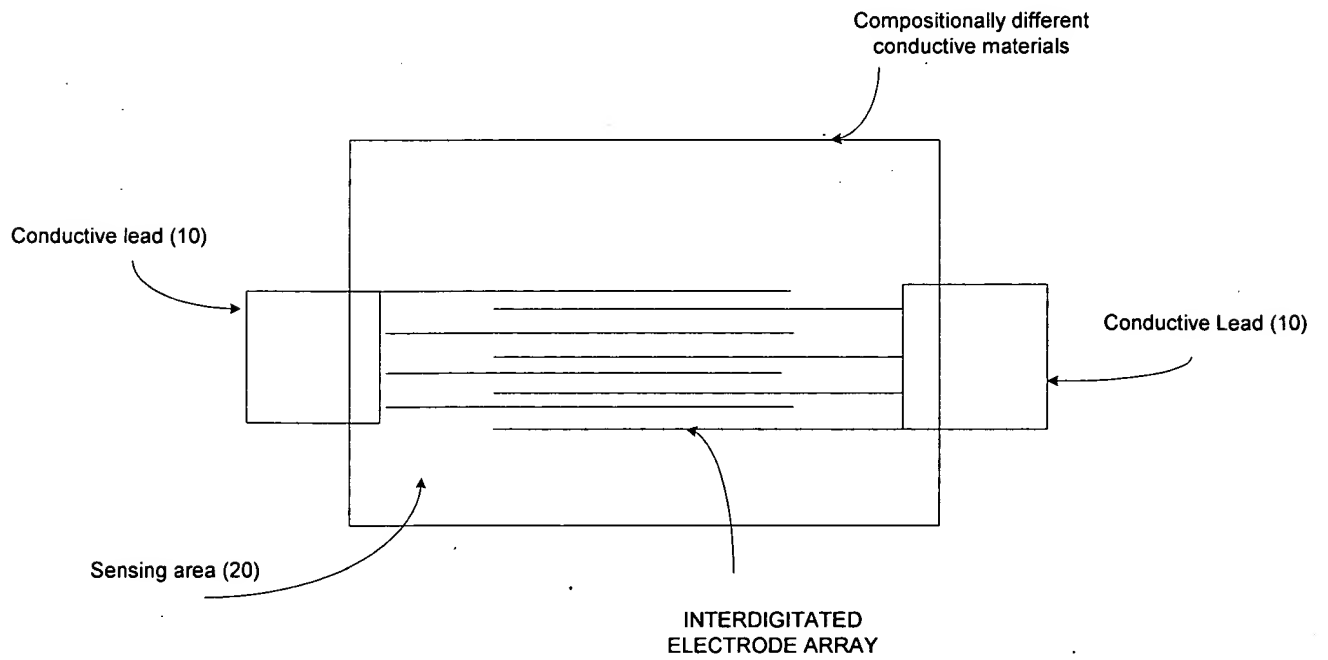
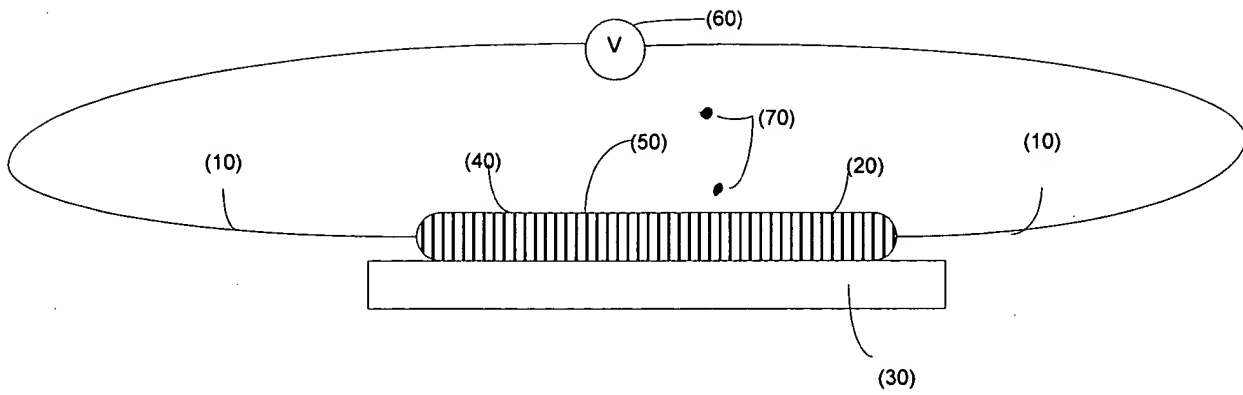


FIG. 1

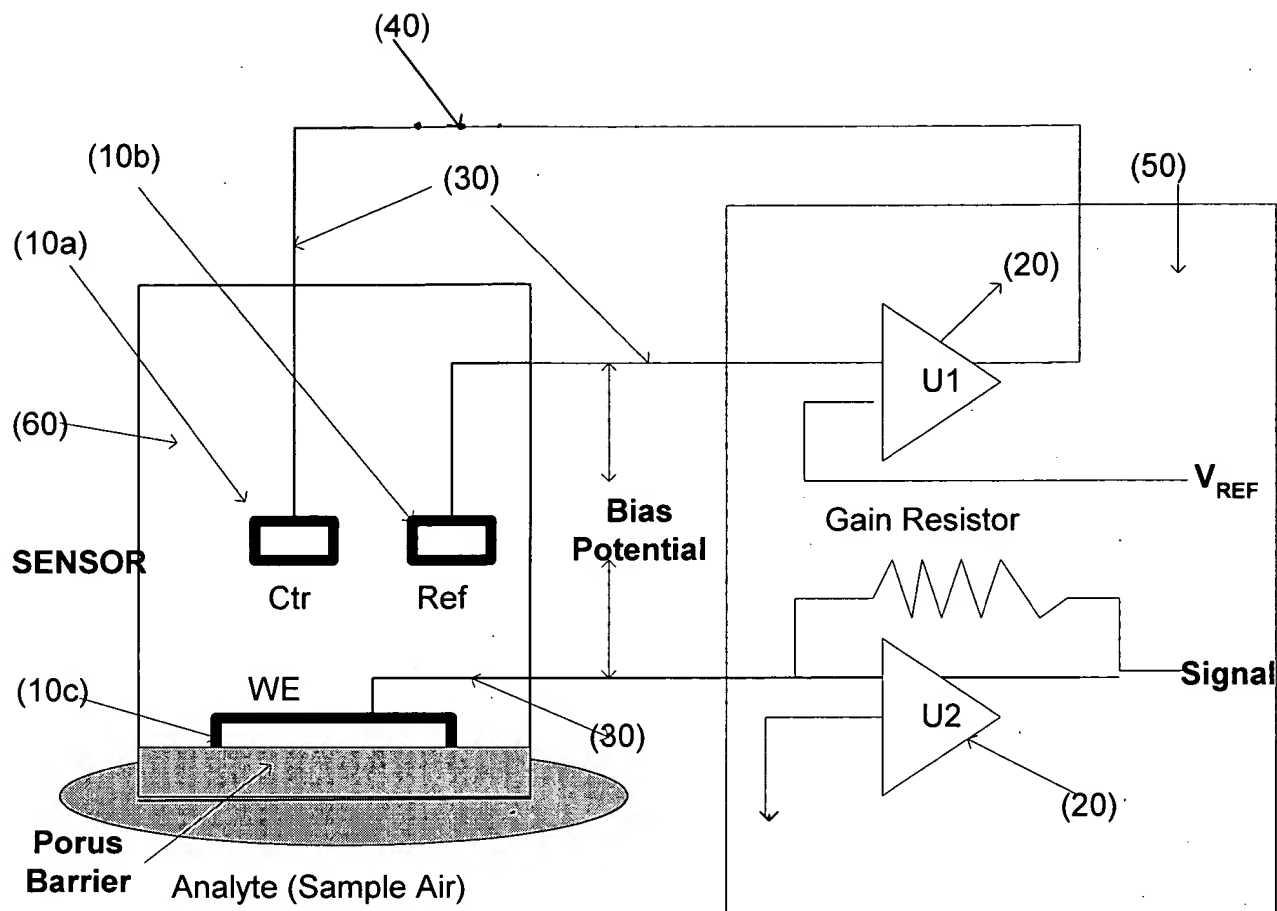


FIG. 2